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AGE AND STRATIGRAPHIC RELATIONS OF THE OLENTANGY SHALE OF CENTRAL OHIO, WITH REMARKS ON THE PROUT LIMESTONE AND SO- CALLED OLENTANGY SHALES OF NORTHERN OHIO

AMADEUS W. GRABAU
Columbia University

The name "Olentangy shale" was given by N. H. Winchell¹ in 1874 to the light-gray soapy shales which underlie the Ohio shale and are exposed on the Olentangy River and its tributaries in central Ohio. Winchell regarded this shale as belonging with the Huron shale which overlies it, but since his day this deposit has usually been classed with the Middle Devonian,² and has been made in a general way the equivalent of the Hamilton formation of New York. The reason for such a grouping seems to have been the fact that in northern Ohio a shale and limestone series lies between the Huron shale and the Delaware limestone and so holds essentially the position occupied by the Olentangy shale in central Ohio. I have elsewhere³ proposed to call this series in northern Ohio the Prout series, from its exposures near the station of that name. In the summer of 1914 I made a detailed study of the several outcrops of this formation in the region about Sandusky, collecting at Plum Creek and paying special attention to the contact of the Prout and Huron formations shown in the exposures at Slate Cut on the Lake Shore Railroad, halfway between Sandusky and Huron, and in the "Deep Cut," about a mile northeast of Prout Station. A summary of my observations was included in the *Report on the Devonian Formations of Michigan* submitted toward the end of that

¹ *Geol. Surv. Ohio*, II, Pt. 1, pp. 287-89.

² The author prefers the term "Devonic" to "Devonian," but has changed it in conformity with the usage of the *Journal*.

³ "Olentangy Shale of Central Ohio and Its Stratigraphic Significance" (Abstract), *Bull. G.S.A.*, XXVI (1915), 112.

year, but unfortunately not yet published. I quote from the manuscript:

The upper $4\frac{1}{2}$ to 5 inches of the Prout has a peculiar character in that it is full of pyrites, is irregularly bedded, and contains much glauconite. Black shale specks and fish teeth are found in the upper half-inch. This upper part of the limestone suggests a weathered and reworked portion very different from the lower part, which is also dolomitized. Some doubtful limestone pebbles have been found at the contact line in the base of the Huron shale, but they are not sufficient in number to be of much value. Altogether, the evidence is inconclusive, but it is not against the assumption of a disconformity [between the Prout and the Huron]. . . .

The abrupt contact and the absence of intergrading are further indications of a pronounced change in sedimentation with a long time interval between the two formations. A comparison of the fauna of the Prout with that of the Traverse group of Michigan, gone into at some length in my report, shows the former to correspond to the lower Traverse of Michigan, i.e., to the beds below the Alpena limestone. I quote again from my manuscript report:

This means that the upper beds were never deposited or that they were removed by erosion prior to the deposition of the black shale, for no one would consider the black shale in any way contemporaneous with the upper Traverse beds of Michigan. Thus an unquestioned time interval is indicated, and since we find elsewhere the black shale disconformable upon the Traverse or other Mid-Devonic beds, we need not hesitate to assume the same relation for northern Ohio. . . . Compared with the sections in northwestern Ohio and in Canada, the evidence becomes quite conclusive that between the Prout and the Huron there is an unrecorded time interval.

Quite recently Dr. Stauffer¹ has returned to a discussion of the correlation of the Prout formation on the basis of its fossils, which he listed in an earlier publication.² He comes to the conclusion that the Prout limestone represents the Encrinal limestone of Eighteen Mile Creek,³ and the shales below it, the lower Hamilton shales of western New York.⁴

¹ C. R. Stauffer, "The Relationships of the Olentangy Shale and Associated Devonian Deposits of Northern Ohio," *Jour. Geol.*, XXIV, No. 5 (July-August, 1916), pp. 476-87.

² *Geol. Surv. Ohio. Bull. No. 10*, 4th Series, 1909.

³ I have proposed the name Morse Creek limestone for this Encrinal of western New York at the meeting of the Geological Society of America, December, 1914, and in the report on *The Devonian Formations of Michigan* above referred to. It is an older limestone than the Encrinal or Tichenor of central New York. See *Bull. G. S. A.*, XXVI (1915), 113.

⁴ Now designated the Wanakah shales by me.

That exact correlation with the Encrinal limestone of Lake Erie is possible may perhaps be doubted, since the calcareous beds increase in number westward. The Encrinal (Morse Creek) limestone is the attenuated eastward extension of the great Alpena limestone of Michigan, and the Prout limestone probably represents one of the lower Traverse limestones of Michigan. Still, Stauffer is undoubtedly correct when he makes the age of the Prout limestone and associated shales lower Hamilton, and it is gratifying to me to feel myself in substantial agreement with one who has made such prolonged studies of these formations and faunas.

When it comes to the Olentangy shale of central Ohio, however, Stauffer and I are in cordial disagreement. He makes it the equivalent of the Prout limestone and shales of the north and so of Hamilton age, while I regard it as a part of the Huron shale series, and referable to the Upper Devonian.

Although I had held this view for many years, it was not until the summer of 1914 that I was enabled thoroughly to test my conclusions in the field. At that time I examined all the important exposures of the formation in Delaware County, beginning with Winchell's type locality, on the Olentangy River. A new section opened here for commercial purposes made a careful study possible. The actual contact between the Olentangy and Huron is sharp, but perfectly even and uniform. In the upper portion of the gray Olentangy are several thin bands of black or chocolate-colored shale of the type of the Huron.

The bedding of the Olentangy shale is chiefly brought out by the occurrence of thin bands of dark shale, and by more or less continuous layers of flat concretions. These are calcareous, up to 2 feet long by 1 foot thick, but mostly smaller. They abound in iron pyrites, as does also the Huron shale overlying. In some sections, as in the Deep Run and Lewis Center and Bartholomew runs, the lower part of the Olentangy shale contains thin bands of impure limestone. In one of these I found fish scales. In all the sections, however, are found the thin bands of black shale in the upper part of the gray, thus indicating a transition of the one formation into the other. At the contact with the first great mass of Huron shale there are sometimes found indications of a slight drying of the surface of the Olentangy, with the formation of cakes

or scales of dry, gray mud, which were then incorporated in the black mud. This is just what we should expect if the deposition of the gray muds had come to an end and sedimentation were renewed by the influx of the black mud from another source. Essentially, however, deposition here was continuous, and after the commencement of the sedimentation of the black Huron mud, there was a temporary recurrence of the gray sedimentation, so that we see today a 10-foot bed with all the characters of the typical Olentangy lying above a considerable thickness of black Huron shale. In both the upper and the lower part of this interbedded mass of Olentangy occur thin bands of black shale, as they do in the typical Olentangy lower down.

The basal contact of the Olentangy and Delaware is not shown in any section which I visited, but the Olentangy could be examined to within a few feet of the contact. There is no interbedding of the Delaware and the Olentangy; the change in material is absolute. The concretionary limestones of the Olentangy are very different in character from the calcarenites of the Delaware limestone. The concretions appear to be of the subsequent type found in the gray Cashaqua shales of western New York, to which the Olentangy shales bear the closest resemblance. Like them, they are unfossiliferous, though fossils are found in some parts of the Cashaqua. The barren nature of both of these shales is in striking contrast with the highly fossiliferous character of the Hamilton shales of western New York, Canada, Michigan and even northern Ohio. A few fragmentary fossils have been found in the calcareous beds, but these might easily be residual specimens weathered from the underlying limestones and incorporated in the new sediment. Such undoubtedly is the origin of the lenticular bed of crinoid fragments found in the type section, which does not exceed 5 inches in thickness. This is apparently a reworked mass of crinoidal fragments dissociated by the weathering of an older crinoidal limestone.

The relationships here presented admit of only one conclusion, namely, that the Olentangy shale is a part of the Upper Devonian, representing a special type of sedimentation, such as characterized the early Upper Devonian sediments of western New York. Sedi-

mentation was continuous from Olentangy into Huron time, but the Huron type alone is represented in northern Ohio, where by overlap it rests upon the eroded surface of the Prout limestone. The latter is absent in central Ohio, where either it was never deposited, or, what is more likely, it was removed by pre-Huron erosion. This erosion extended down to the Delaware limestone, though it is not impossible that a part of the lower Prout series is represented in the central area by the Delaware limestone itself. If the name "Prout" is to be restricted to the limestone member of the northern series, then the shale below it must receive another name. It certainly is not Olentangy, which name belongs to the earliest Upper Devonian formation of central Ohio. In my report on *The Devonian Formations of Michigan* I have proposed the name "Arkona beds" for the shales lying below the Encrinal limestone of the Thedford, Ontario, region. If, as Stauffer holds, the shales below the Prout limestone are the equivalent of these Ontario shales, which he calls Olentangy, then the name "Arkona" may also apply to them. It may be wiser, however, to refer to them as the Plum Creek shales, since the distance between Arkona and Plum Creek is too great to permit of positive identification. True, Dr. Shimer and myself correlated the Encrinal limestone of Thedford with that of western New York, on the basis of faunal characters, and this correlation may be correct. At the same time, we now know that the Encrinal of western New York (Morse Creek) and that of central New York (Tichenor) are not the same beds. I have also shown¹ that the faunas of the shales below the Morse Creek in Eighteen Mile Creek occur in the shales above this limestone 60 miles to the east, where they are not found below that limestone. I have also shown that this typical Hamilton fauna is absent from the beds above the Morse Creek limestone at Eighteen Mile Creek, there being thus a complete inversion of faunas. On purely faunal grounds the shales below the Morse Creek at Eighteen Mile Creek would be correlated with the shales above that bed at Moscow and elsewhere in the Genesee Valley. The explanation of this and the relation of the western New York Hamilton faunas to the Thedford and Michigan Traverse

¹ "The Faunas of the Hamilton Group of Eighteen Mile Creek and Vicinity in Western New York," *16th Annual Report, N.Y. State Museum*, 1898, p. 330.

faunas is fully set forth in the unpublished report referred to. There, too, it is shown that the faunas of the Traverse group on opposite sides of the state of Michigan differ materially, while identification of equivalent limestones and shales between the two sections is impossible. All of these facts would lend some force to the suggestion that precise correlation of the Prout limestone and Plum Creek shales with the Encrinal limestone and Arkona shales of the Thedford region should not be too rigidly insisted upon. Nevertheless, we may with Stauffer lay much stress on the presence of the *Bactrites* layer at about 25 feet below the Encrinal at Arkona and a similar distance below the Prout limestone at Plum Creek,

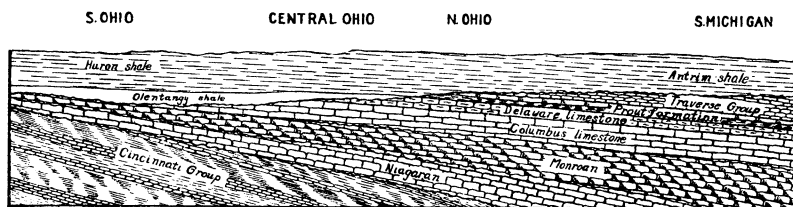


FIG. 1.—A generalized north-south section through Ohio and southern Michigan, showing the relations of the Olentangy shale and the Prout formation.

containing at both places pyritized *Bactrites arkonensis* and *Tornoceras uniangulare*, besides *Nucula triqueter* and *Leda rostellaria*. Then, too, as Stauffer has shown, the faunas of the Prout limestones of this and of the Encrinal of Ontario are very similar, the latter containing over 75 per cent of the species found in the former. On the whole, therefore, Stauffer's position seems well taken, and we may accept his correlation of the Prout limestone with the "Encrinal" of Thedford and perhaps with the Encrinal (Morse Creek) of western New York.

We cannot, however, use the name Olentangy for the shales below these horizons, and therefore the Canadian term "Arkona shales" is preferable. This name may be then applied likewise to the shales of Plum Creek. The comparative study of the brachiopods of these various shales, now in process, will throw further light on the provincial relationships of these formations.

Let us return once more to the typical Olentangy shale of central Ohio, which we have seen is of Upper Devonian age. It rests disconformably upon the Delaware limestone, which represents some of the lower Traverse beds of the Michigan region. There is thus a great hiatus between the Delaware limestone and the Olentangy shale in central Ohio, cutting out the greater part of the Traverse group. This hiatus increases southward, so that in Pickaway County the Olentangy shale lies in places upon the lower Columbus and elsewhere upon the Monroan, and in all cases it is succeeded by the black Huron shale. At Bainbridge, in Ross County, it even rests upon the Niagaran. The Olentangy is still represented at Vanceburg, Kentucky, on the Ohio River and near Fox Springs, Fleming County, Kentucky, according to W. C. Morse. A generalized north-south section through the region named brings out the magnitude of the post-Traverse erosion, and also shows that the Olentangy shale is of the nature of a lentil, disappearing to the north and to the south. The source of the Olentangy was probably local and circumscribed, representing perhaps an accumulation in Upper Devonian time of a residual soil produced from the weathering of the underlying rocks. It may possibly be an extension of some of the eastern gray shales of the Upper Devonian, such as the Cashaqua. The Black Huron shale I hold to be a deposit of carbonaceous mud washed into the shallow Upper Devonian sea by the rivers coming from the Devonian peneplanes to the south and representing probably our best case of an estuarine deposit in the American Paleozoic. The details of this and the relation of the Huron to the Chattanooga shale, which latter I consider mostly a terrestrial residual soil, reworked in Mississippian time by the encroaching sea, are set forth at length in the monograph on *The Devonian Formations of Michigan* to which reference has several times been made.